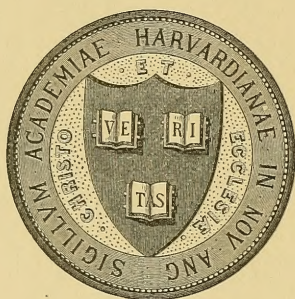




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DEPARTMENT OF AGRICULTURE,

SYDNEY,

NEW SOUTH WALES.

A NEMATODE FORMULA:

BY

N. A. COBB.



SYDNEY: CHARLES POTTER, GOVERNMENT PRINTER.

1890.

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A. Nematode Formula.

By N. A. COBB.

I PROPOSE in the near future to describe in a series of papers a large number of hitherto unknown Nematodes. As many of these papers as appear in the reports of this department will treat of those Nematodes which live in or upon plants, often thereby causing diseased conditions whose nature it is highly important to understand. In order to bring the characterizations into small compass, and thus gain space for the fuller discussion of such morphological, physiological, and pathological problems as may present themselves, I shall make use of a new formula which expresses briefly and accurately the necessary measurements.

Inasmuch as this formula will occur once or twice in the description of each species, and be made to bear such a large share of the burden of characterization as to become in a systematic sense a prime factor in the work, it merits at the outset a full elucidation.

Since the middle of the present century nematelmithologists have shown an ever-increasing regard to absolute and relative dimensions. Dujardin (1846) gave the length, the ratio between the length and breadth, and occasionally other dimensions, such as the length of the tail and the position of the vulva. No one did more than this until Eberth and Bastian, working simultaneously on the Anguillulidæ, saw the necessity for further particularization. These two investigators, the one in Germany, and especially the other in England, laid firm the foundation of the important superstructure afterward raised by Bütschli, Marion, De Man, Von Linstow and others. The appearance of their works (Eb. 1863, Bast. 1866) marks an era in the history of our knowledge of the group of which they treated. Their texts were accompanied by accurate and well executed figures of both extremities of each worm described. The dimensions given, based sometimes it is true on too few or otherwise too imperfect measurements, related to the length, breadth, position of the vulva, depth of the buccal cavity, and the fraction of the entire length occupied by the tail and œsophagus respectively. To these Bastian added the dimensions of the spicula and striæ. The English author, making the inch his unit of length, contented himself with giving a categorical list of the measurements made. Thus, taking a species at random, *Enoplus pigmentosus* was entered as $\frac{1}{2} \times \frac{1}{160}$; teeth, $\frac{1}{66}$; œsophagus, about $\frac{1}{2}$ (i.e., of the total length); tail, $\frac{1}{160}$. This is manifestly not very convenient for the reader. The German author, making the millimeter his unit of length, followed the same plan as his English contemporary but gave fewer measurements, trusting no doubt that the exquisite figures accompanying his text would supply all necessary information concerning details. Bütschli, the renowned Heidelberg naturalist, followed (1873-4) the plan adopted by Bastian and Eberth, but brought to his aid a greater amount of pictorial art. His figures are full length portraits, accompanied by figures on a larger scale, the latter illustrating the details of the head, tail, &c. Marion (1873) furnished no new ideas to the nomenclaturist. De Man, however, has introduced decided improvements in nomenclature. Realizing the

necessity for exactitude and completeness in the matter of measurements, this author, who has described a greater number of new forms than any of his predecessors in the same field, and added also very essentially to our knowledge of the Nematode anatomy in general, has adopted a series of ratios by which a considerable number of measurements are expressed very concisely. These ratios he represents by the Greek letters α , β , γ , his α being the ratio of the length to the median (greatest) diameter, β the ratio of the total length to the length of the œsophagus and γ the ratio of the total length to the length of the tail. Thus, after having given the absolute length, he is enabled to give three remaining dimensions by means of such an expression as the following: $\alpha = 45$, $\beta = 5$, $\gamma = 8$.

The formula which I now propose points out, by means of eleven numbers, eleven dimensions, and serves at the same time to indicate the sex from which the measurements were taken, as well as the general form and size of the sexual organs. The following are my formulæ for a species of *Oncholaimus*:—

Female.					Male.				
1'	8'2	17'2	52	93'3	1'77	·8	8'	16'6	M 94'1
·9	1'5	1'6	1'7	·8	·8	1'3	1'4	1'4	·8 1'85

The formula for the male is distinguished from that for the female by the use of the letter M, for reasons presently to be stated. In order to exhibit in as graphic manner as possible the nature of this new formula, I have desired the printer to set up the above formula for the female in special type as follows:—

	Pharynx.	Nerve-ring.	Base of Neck.	Vulva.	Anus.
Lengths	1'	8'2	17'3	52	9'33
Diameters	·9	1'5	1'6	1'7	·8
	Pharynx.	Nerve-ring.	Base of Neck.	Vulva.	Anus.

The numbers above the horizontal line relate to longitudinal measurements, while those below it relate to diametral measurements. The first number above the line (1') represents the distance from the anterior extremity of the animal to the bottom of the pharynx or buccal cavity. The first number below the line (·9) represents the length of the body-diameter which passes through the base of the pharynx. The second number above the line (8'2) represents the distance from the anterior extremity of the animal to the centre of the nerve-ring; and the number directly below (1'5) represents the length of the corresponding diameter, *i.e.*, the body-diameter passing through the nerve-ring. The third pair of numbers (17'3 and 1'6) represent measurements relating to the posterior end of the œsophagus or base of the neck. In other words, 17'3 is the distance from the anterior extremity of the animal to the posterior end of the œsophagus, or is the length of the neck including the head; and 1'6 is the diameter of the body at the point where the œsophagus joins the intestine, *i.e.*, where the neck joins the body. Finally, 52 and 9'33 are the distances from the anterior extremity to the vulva and the anus respectively, and 1'7 and ·8 are the lengths of the corresponding diameters. It will be seen that the different dimensions are taken up in the formula in a natural order. Reading the formula from left to right reads off the dimensions of the animal from head to tail. Now comes the peculiarity of the formula: *The unit of measurement is not absolute but relative*, is, in fact, nothing else than the hundredth part of the length of the worm itself. In other words, the measurements are

expressed as percentages of the total length of the animal. Thus, the first measurement (1·) indicates that the depth, *i.e.*, the length, of the pharynx is equal to 1 per cent. of the total length of the body. So the measurements for the base of the neck indicate that the length of the neck is equal to 17·3 per cent. of the body-length, while the length of the diameter at the base of the neck is equal to 1·6 per cent. of the body-length. The absolute length of the animal expressed in millimeters is placed at the right. In the present case that length is 1·77 millimeters.* In the formula for males the measurements relating to the vulva of the female are replaced by measurements relating to the middle of the body. The fourth number above the line becomes, therefore, always 50, and is indicated by M. The number below M gives the diameter of the male at the middle. In other respects the formula for the male is similar to that for the female.

Unless otherwise stated all measurements must be understood to be taken from adult specimens as they appear in profile.

By the use of certain signs the fourth term above the line may be made to convey an idea of the form and size, as well as the position, of the sexual organs. The female genital organs lie either on one or both sides of the vulva, and the branches are either straight or reflexed. Letting a hyphen represent a straight, and a quotation mark a reflexed branch, we have—

- 52·1- indicates two straight branches, one on either side of the vulva.
- '52·1' indicates two reflexed branches, one on either side of the vulva.
- 52·1- indicates one straight branch behind the vulva.
- 52·1' indicates one reflexed branch behind the vulva.
- 52·1 indicates one straight branch in front of the vulva.
- '52·1 indicates one reflexed branch in front of the vulva.

In case of the male—

- M- indicates two straight testicles extending in opposite directions.
- M indicates one straight testicle extending forwards.
- M- indicates one straight testicle extending backwards.
- M' indicates one reflexed testicle extending backwards.
- 'M indicates one reflexed testicle extending forwards.

It should be borne in mind that the marks in the case of the male refer exclusively to the form and position of the testicle proper, that is to say, that portion of the generative apparatus beyond the vas deferens. When two testicles are present their limits are easily defined, for the point where they join marks the beginning of the *vas deferens*. When but a single testicle exists it is marked off from the *vas deferens* by a constriction in the same way that the *vas deferens* is marked off from the *ductus ejaculatorius*.

The percentage of the body occupied by the sexual organs is indicated by superior or reference figures placed at the right of and above the fourth term. Thus '50'³⁰ represents a female sexual apparatus whose vulva is central, and whose symmetrically reflexed branches occupy 30% of the length of the body.

* Dividing 1·77 millimeters by one hundred, we obtain the unit of length used in the remainder of the formula. The result is '0177 millimeters. If it is desired to obtain the absolute length of the pharynx, neck, or other part, multiply the proper measurement by this co-efficient ('0177). This gives for the absolute length of the pharynx $'0177 \times 1 = '0177$ millimeters, and for the length of the neck $'0177 \times 17.3 = '3$ millimeters. It is well known, however, that absolute dimensions, in such a case, are of very little consequence, while relative dimensions are of the greatest importance, and the great advantage possessed by such a formula as that now under consideration is that relative dimensions are made prominent.

One may quickly familiarize himself with this new formula by imagining that the horizontal line represents the animal under consideration, and that the dimensions are written alongside, opposite the proper parts,—that is, opposite the base of the pharynx, the nerve-ring, the base of the neck, the vulva and the anus.

Being already familiar with the use of this formula, I am not a proper judge of the difficulties that would occur to a novice in its use. To me the most obvious difficulty is that of having always to consider the anus with reference to its distance from the anterior instead of, as is usual, from the posterior extremity, a difficulty which should disappear with a little practice. It is much easier to enumerate what seem to me the advantages of the formula.

- (1.) The position of each number indicates the dimension to which it refers. The formula is thus brief, yet concise.
- (2.) The position of the nerve-ring is indicated. In properly prepared specimens the position of the nerve-ring is clearly to be seen, so there is no longer any reason why the position of so important an organ should not be entered among the characteristics. In order to see at once the relative position occupied by the nerve-ring, comparison should be made between the second and third numbers above the line. It will be thus seen that in the species whose formula has been given, the ring is situated a little in front of the middle of the neck.
- (3.) A glance along the lower line of the formula reveals at once the general form of the body. The worm whose formula has been given has a somewhat cylindrical body. The portion of the neck in front of the nerve-ring tapers considerably. The body also tapers considerably in front of the anus. This latter is patent from comparison of .8 with 52.1. The vulva is central, which means that the sexual organs are probably double and symmetrical. Therefore, the body would not be likely to diminish much in size in the immediate vicinity of the vulva. Hence the decrease in size (1.7 to .8) must take place considerably behind the vulva, and therefore near the anus. In very plump worms the largest of the numbers below the line may rise as high 10, in slender ones become less than unity.
- (4.) By averaging the specific formulæ of a genus, we may obtain a generic formula. During phylogenetic and systematic studies the specific and generic formulæ greatly facilitate the necessary comparisons.

The following description of a new species of *Oncholaimus* will illustrate the use of the formula:—

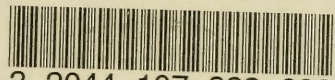
***Oncholaimus index*, n. sp.** $\frac{1 \cdot 7 \cdot 5}{1 \cdot 1 \cdot 7} \frac{14 \cdot 2}{2 \cdot 2 \cdot 3} \frac{45 \cdot 0}{2 \cdot 3} \frac{95 \cdot 6}{1 \cdot 281}$. The thin cuticula is destitute of striæ. By careful use of high powers short submedian hairs may be discovered throughout the length of the body. The conoid neck terminates in a very slightly compressed head, which, at first glance, seems to be entirely naked, but is seen after careful focussing to bear six very short setae, two lateral and four submedian, all opposite the apex of the longest pharyngeal tooth. When the worm is seen in the dorso-ventral aspect, the two circular lateral organs appear like two small oblique open pockets opposite the middle of the pharynx. Six thin lips, each having the form of an isosceles-spherical triangle, together form a flat-topped dome over

a pharynx which is about half as wide as deep and which is armed with three teeth, two sub-equal ones reaching half-way to the lips, and a third, the left submedian, stouter and half as long again. Passing the pharynx, the food enters an œsophagus which is in its anterior part less, but in its posterior part more, than half as wide as the neck. Passing then through the rather large cardia, it enters the intestine, whose commencement is indicated by a distinct but shallow cardiac collum. This moderately thin-walled intestine is composed of a single layer of cells, of which about fifteen side by side make up the circumference, and terminates posteriorly in a rectum whose length is hardly greater than that of the anal diameter. A sac-shaped unicellular ventral gland, as long as the body is wide, lying nearly as far behind the cardia as the slightly oblique nerve-ring is in front of it, empties, by means of a long narrow duct and a distinct narrow-necked ellipsoidal ampulla, through the porus excretorius, situated about as far behind the base of the pharynx as the latter is behind the lips. The lateral fields are about half as wide as the body. They are usually conspicuous at both extremities, but especially the posterior, through the presence in them of numerous pigment granules. The narrow median fields, one-ninth as wide as the body, are much less readily distinguished. The tail of the female is conical to its somewhat clavate posterior third. It presents a slightly swollen terminus having a conical outlet for the three caudal glands, the most remote of which lies near the commencement of the posterior fifth of the body. Three or four thin-shelled, oblate, unsegmented eggs, as long as the body is wide, are usually to be seen lying in the uterus near the rather inconspicuous vulva. Small one-celled glands encircle the very short vagina. The multicellular, bilaterally-symmetrical organ discovered by De Man is situated between the vulva and anus.

$\frac{1.3}{1.2} \frac{8.4}{1.7} \frac{15.5}{1.9} \frac{-M.50}{2.3} \frac{97.3}{.8} 24.$ The male tail narrows gradually from opposite the proximal ends of the spicula, becoming at the anus suddenly finger-shaped by diminishing abruptly on the ventral side. The finger-shaped portion has a diameter one-half as great as the anal diameter, and gives to the posterior extremity of the worm when seen in profile the general form of an index (). Two minute, bristle-bearing, submedian papillæ, pointing backward, appear on each side immediately behind the anus. Opposite the posterior third of the two equal, linear, barely arcuate, pointed spicula stand yet other papillæ, to the number of about six or eight, those nearest the anus being submedian, but one or two of the more remote appearing to be median. The spicula, when seen in profile, appear to make but a slight angle with the axis of the body. They are a trifle more than one-half as long as the tail, or a little more than twice as long as the anal diameter, are destitute of accessory pieces and possessed of proximæ hardly to be called cephaloid. The testicles join the vas deferens near the middle of the body. The region occupied by the ductus ejaculatorius commences at the beginning of the posterior fifth of the body, and is supplied with oblique copulatory muscles.

Both sexes about equally common in sand and among weed along the shores of Port Jackson, New South Wales, October, 1889.

I hope by the aid of this new formula to be able to describe, even without the aid of figures, at least such species as belong to already well known genera, so accurately as to leave little to be desired, and yet so briefly as to leave space for the full discussion of the important relations existing between these worms and diseases of plants.



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